

AN ARCHAEOLOGICAL POLLEN ANALYSIS OF JOE'S VALLEY ALCOVE

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# ABSTRACT

Palynological and radiocarbon data from Joe's Valley Alcove are presented and analyzed in the context of comparable information from Nevada, Utah, Colorado, New Mexico and Texas. One result is identification of a general paleoenvironmental model covering the 8300-8000 B. P. period for a part of the American Southwest. A second result is a reconstruction of the character of paleoclimatic variations affecting resources in the site catchment area of Joe's Valley Alcove during its Archaic occupation. The implications of these results to theories of the anthropology of Southwestern Archaic populations are considered.

## INTRODUCTION

Joe's Valley Alcove (ML-1932) is located on the Monti-LaSal National Forest near Farron, Utah, in the east-facing portion of the southern half of the Wasatch Range. The rockshelter has been known for many years as a Fremont location but in 1972 a rock slide exposed Archaic Horizon cultural materials which previously had been totally sealed beneath a rock collapse. United States Forest Service archaeologists quickly recognized the potential for loss of Archaic cultural resources of the site, for the shelter is easily observed from the highway passing below its talus. The bulk of exposed Archaic materials were therefore salvaged under controlled conditions in 1973. A preliminary report of archaeological research at Joe's Valley Alcove is filed at the Inter-Mountain Regional Office of the U.S.D.A. Forest Service at Ogden, Utah, and a final report is in progress.

A number of charcoal samples recovered from the site during the 1973 excavation were dated very soon after the excavations were completed, and sediment samples that had been collected were submitted to the Palynological Laboratory of the Department of Anthropology at Arizona State University after the radiocarbon results were known (Schoenwetter, 1974). The stratigraphic relationships of the radiocarbon and pollen records offered opportunity to determine the degree to which palynological information might independently confirm or deny the radiocarbon dating of the site. It was also anticipated that the palynological record would provide archaeologically significant reconstructions of the Archaic Horizon paleoenvironment of the site.

As it commonly used by the archaeologist, the term environment has a number of meanings which are not anthropologically equivalent.

(No R) In its specific sense, the environment of a site is the immediate territory exploited by the site's occupants for raw materials and energy sources during their period of their residency. In a somewhat more general sense the term refers to the character of biophysical conditions, such as vegetation patterns and climatic patterns, in such a territory or over a region in which the resident population may have accessed sources of materials, energy and information over the course of a number of generations. In a broader sense, the term refers to both the biophysical and the cultural contexts to which the behavior of the population residing at a site may have been related. In this usage, the term references conditions which may have continental geographic scale and time depths of millenia or tens of millenia. Discussions of the "environment" of forms of early man often adopt this usage.

In the Joe's Valley case the archaeologist's interests are site-specific in the short range of anthropological analysis and regional at the long range. Pollen study contributes to the former by reconstructing the environment of the site's probable catchment area in floristic, ecological or meteorological terms that will aid reconstruction of prehistoric lifeways. The palynologist makes a significant contribution to the latter by reconstructing the geographical extent and durational scales of variations in regional paleoecological and paleoclimatic conditions. It is widely thought that if the character of climatic conditions and the geographical boundaries of climatic zones varies through time, the adaptive responses of biota will probably change

to assure survival. Under such conditions one would expect the customary behavior patterns of human populations dependent on that biota for raw materials and energy to also undergo adaptive change.

The concern of this study with the three issues of chronology, regional paleoenvironmental reconstruction and site paleoenvironmental reconstruction have structured this report in a very unusual way. Most pollen studies proceed from the analysis of sample-specific information to the development of site and regional-level inferences in successive stages. The nature of the available data from Joe's Valley happens to be such that neither the chronology nor site environment issues can be addressed solely through assessment of the sample-specific information, however, and the regional environment issue cannot be addressed confidently except from the perspective of a regional paleoenvironmental reconstruction. It is therefore necessary to describe the sample-specific record fully at first in order to identify for the reader what difficulties are encountered when attempts are made to assess it on its own terms. To resolve these problems this work next turns to the establishment of a regional-level paleoenvironmental model synthesized from other bodies of information. Once a general model has been developed, the results of the Joe's Valley pollen study are evaluated by consideration of their accordence or discordance with expectations generated by the model. Finally, after a summary section which recapitulates the argument, conclusions are offered about paleoenvironmental variations through time at the site-specific level.

## GROSS STRATIGRAPHY AND RADIOCARBON

Joe's Valley Alcove stratigraphy is most concisely characterized in terms of four superimposed units. The uppermost deposit containing a normal range of artifactual materials of the Fremont culture. Below this is a roof collapse deposit of massive blocks infilled by sand (Bed II) which contains hearths but no portable artifacts. The roof collapse totally sealed a deposit containing cultural materials of typical Archaic styles. This lower deposit, Bed I, was divided into excavation levels on the basis of apparent natural strata distinctions. It overlies an older (culturally sterile) depositional unit which was not excavated or sampled.

A suite of radiocarbon assays establishes the antiquity of the levels of the Bed I deposits and confirms the archaeological date estimation of the Fremont Horizon (Table I). All dates are consistent with the relative stratigraphic positions of the samples collected and all but two (RL 430, RL 432) are consistent with the typology of directly and indirectly associated artifactual remains. The radiocarbon record thus offers substantive evidence supporting the sedimentological evidence that the levels of Bed I which were sampled for pollen analysis represent distinctive, sequential, depositional intervals.



Laboratory Number	Radiocarbon Years Before Present	Provenience
RL-499	930 $\pm$ 100	Firehearth; Bed III
RL-497	1410 $\pm$ 100	Firepit Charcoal, Bed III, Level 2A northern area
RL-498	1650 $\pm$ 100	Firepit Charcoal, Bed III, Level 2A northern area
RL-429	1830 $\pm$ 120	Charcoal from Firehearths, Bed III, level 2, northern area 3-4 cm above contact with culturally sterile deposits
RL-432	2460 $\pm$ 120	
RL-430	2410 $\pm$ 130	Scattered charcoal at contact between cultural and culturally sterile deposits, Bed III Level 2, northern area
RL-431	3520 $\pm$ 200	Ash lens, upper Bed II. No associated cultural material this bed
RL-353	6200 $\pm$ 190	Scattered charcoal, Bed I, upper level 3
RL-352	6760 $\pm$ 180	Wood charcoal, Bed I upper level 2
RL-355	7670 $\pm$ 210	Charcoal, Bed I, level 1. Associated with feature 30
RL-354	7770 $\pm$ 230	Wood charcoal, base of Bed I, level 1, at contact with basal sterile
RL-356	8210 $\pm$ 220	Wood charcoal, Bed I level 0

Table I: Radiocarbon assays of Joe's Valley Alcove, calculated on the Libby half-life of 5568 years. All samples pre-treated by Radiocarbon Ltd.





## PALYNOLOGY

The sediment samples submitted for pollen analysis were of three sorts. A series of three samples from talus deposits below the rockshelter as modern pollen rain controls. The spectra of these samples ostensibly identify the proportions of pollen of different plant taxa which are trapped and preserved in depositional environments at Joe's Valley Alcove today. They also identify the range of variation in pollen frequency values expectable under modern environmental conditions at the site location. As Figure 1 makes obvious, the frequency values of this series of samples are both uniform and distinct from those recorded for the samples from Bed I. The total arboreal pollen (AP) frequency value ranges from 65 to 71.5%, the pine:juniper ratio value ranges between 1.0 and 2.0 and the grass pollen frequency value ranges between 2 and 4%.

The second group of samples consists of one collected from the Fremont cultural horizon and one from Bed II. Since a single pollen spectrum is not a statistically adequate basis for interpretation, and each of these samples must correspond to very different temporal intervals, discussion of them as a set will be forgone. It is of interest, however, that the pollen record available for the Fremont horizon is not unlike those of modern surface samples. Though it is at least 800 years older than any pollen record of the surface series, it is a member of the same statistical population.

The third group of samples consists of a series of samples from the surface series. At profile 236 a single sample was collected from each of the

three super-imposed levels of Bed I. At profile 186, samples were collected at arbitrary 5 cm intervals. This resulted in the recovery of one sample from each of levels 3, 2 and 0; one sample from a lens deposit intervening between level 0 and level 1; and five samples from level 1 in stratigraphic order.

The two samples collected from level 3 of Bed I have quite different pollen spectrum characteristics. The one from profile 235 yields an AP frequency value of 53%, a pine:juniper ratio of 95.0 and a grass pollen frequency value of 23%. The spectrum from the same stratigraphic level at profile 186 has an AP frequency value of 19.5%, a pine:juniper ratio value of 12.5, and a grass pollen frequency value of 20.6%. The small number of records of this stratigraphic unit makes statistical argument for or against the conclusion that both are members of a single highly variant population equivocal, but it seems unlikely. This position is reinforced by the fact that the pollen record of Bed I level 3 from profile 235 is statistically similar to the record from Bed II in most regards; the evidence of the surface sample data that pollen frequency populations of this locality display little variability; and the radio-carbon evidence that the absolute interval between <sup>the</sup> end of the Bed I level 3 deposition and the end of Bed II deposition may be of considerable duration. The simplest hypothesis to explain the difference between the two records is that they represent the pollen rains of distinctive intervals within the period of deposition of level 3. Evidence to support this hypothesis is not available in the existing record, but I shall accept it for interpretive purposes.

The two pollen spectra of the level 2 deposits of Bed I, by contrast,

are members of the same statistical population. The spectrum of the sample from profile 236 contains 92% AP, has a pine:juniper ratio of 43.0, and yielded 7.5% grass pollen. The spectrum of the sample from profile 186 contains 74% AP, has a pine:juniper ratio of 142.0, and yielded 15% grass pollen. Compared to the population of pollen records of the surface and Fremont contexts, those of Bed I level 2 are distinctive in their higher mean AP value, the much lesser significance of juniper and all types of arboreal pollen other than pine, the higher mean frequency for grass pollen, and the lesser significance of chenopod and composite pollen. The latter characteristic is probably induced by the mathematical constraint of the higher pine pollen value, however, rather than a reflection of paleovegetation patterning.

The palynological characteristics of the six samples of level 1 are similar in two ways. First, pollen density in these samples is uniformly lower than is the case for the samples of levels 2 or 3. Second, the samples are members of a single statistical population in which AP frequency values range from 25 to 33.5%, pine:juniper ratios range from 1.3 to 65.0 and grass pollen frequency values range from 35 to 58%. The palynological and stratigraphic characteristics of this population of spectra are unique. The pollen spectrum from level 3 of Bed I at profile 186 is superficially similar, but its distinctive pine:juniper ratio and Artemisia pollen frequency value are sufficient to exclude it from this population.

The pollen records from the deposit between levels 1 and 0 and from level 0 at the profile 186 location derive from stratigraphically distinct units. Since they are single samples, it is impossible to evaluate the degree to which they characterize the pollen rains of their respective

horizons by statistical methods. The spectra involved, however, are not similar to each other nor to members of the level 1 pollen record population. If they are assumed to be representative records of the two temporal horizons indicated by their stratigraphic position, they indicate that the pollen rain of the very earliest human occupation of Joe's Valley Alcove was dominated by grass pollen (76.0%) and almost entirely devoid of arboreal pollen (6.3%), while the pollen rain of the succeeding period was dominated by arboreal pollen (70%). The younger of these records is a statistical member of the population of pollen records of level 2, though its stratigraphic position obviates the possibility of contemporaneity.

#### DISCUSSION

Both the dating and the paleoenvironmental interpretation of the pollen records of Bed I are hindered by low sample numbers, since radiocarbon dating and pollen analysis are statistical operations which rely upon assessment of population characteristics for accurate results. Each of the stratigraphic levels of Bed I is a differentiable depositional event. The durational parameters of each event, however, are probably not identical at all loci within the rockshelter. Determining the span of radiocarbon years represented by any given level of the Bed I unit, then, demands multiple samples. Multiple samples are also demanded to establish a defensibly accurate estimate of the probable mean antiquity of a given level.

There are two independent lines of evidence, however, which justify accepting the assumption that the available dates approximate the antiquity of the depositional events expressed as levels in the Bed I deposit. One of these is the sequentiality of the dates, when considered in light of



their relative stratigraphic positions. Though the accuracy of any one of the dates remains unassessable, it seems likely that only accurate dates would maintain relative stratigraphic consistency. It should be noted, in this regard, that the apparent distinction in antiquity between the two dates from level 1 is not real, despite their relative stratigraphic positions. The probability that the base of the level 1 deposit is in fact about 100 years older than feature 30 is almost infinitesimal, given the standard errors of the two samples. The duration of the depositional episodes is simply not evaluable from these data.

The second line of evidence is the conformity of these estimates with those provided by other cultural and depositional events in the region. Archaeological evidence of Archaic occupations in southeastern Utah is minimal (Jennings 1978), but satisfactorily documents the presence of human populations between 8500 and 6000 radiocarbon years B.P. At Pint-Sized Shelter, located in the dissected piedmont southeast of the Wasatch Plateau, a series of cover sand accretion depositional episodes occurred interrupted by periods of cover sand stabilization (Curry 1976). The earliest episodes of accretion and stabilization are dated to the 5500-8000 BP period by correlation with accepted dates for the Altithermal interval. Variations in deposition patterns are also dated to the 8000-6000 BP horizon at Sudden Shelter, east of Salina, Utah (Currey 1980), and Cowboy Cave (Jennings 1980). Such observations do not constitute evidence sufficient to demonstrate that regionally synchronous modifications of environment occurred which precipitated synchronous depositional changes during the 8000-6000 BP period. They suggest this hypothesis, however, to the degree that Jennings (1978) and Currey (1976) have ad-

vanced interpretations of regional changes in effective moisture patterns concurrent with climatic variations in the northern hemisphere. Deposition variations which occur at Joe's Valley Alcove are consistent with the hypothesis advanced, and even predictable from that hypothesis, if the Joe's Valley dates are accurate. This serves to place to the burden of proof that the Joe's Valley dates are inaccurate on those who would advance alternative hypotheses for the apparent concordance of depositional variations in the regional record.

Interpretation of the pollen records of Joe's Valley Alcove logically pivots not on the question of what paleoenvironmental conditions they may reflect, but whether the records are interpretable at all. Interpretation is justifiable only for populations of pollen records in which sample size is adequate to the task of statistical evaluation. Only the population of surface pollen records and the population of pollen records of level 1 meet this requirement, and even then the argument would be recognizably weak. What it all boils down to is the credibility of the postulate that the single pollen records of different sorts from level 0, the deposit between levels 0 and 1, level 3, and the two pollen records of level 2 may be treated as characterizing different populations of pollen records.

One basis for accepting this postulate is recognition that each of those potential populations is temporally distinct. A second basis for accepting the postulate, given that each is distinct, would exist if evidence from other locales indicates that variation in populations of pollen records during the time intervals involved is expectable, rather than lack of variation. In essence, we grant the credibility of the



postulate to some degree if we grant that the radiocarbon dates for the levels of Bed I are accurate. We grant its credibility further if we identify a correspondence in the pattern of pollen-time variation occurring at Joe's Valley Alcove and other locations.

The argument for acceptance of the Bed I radiocarbon dates as accurate estimates of the antiquity of the depositional units of Bed I has been made above. If granted, the pollen-time variations observed at Joe's Alcove would be recognized as a series of pollen rain populations in which the frequency of arboreal pollen is modified most dramatically over time. The sequence begins about 8200 B. P. when the AP frequency value is at a level barely above the point of statistical significance (6.3%). Between that date and the time of the initial deposition of level 1, which could not be much later than 7700 B. P., the AP frequency value increased to a level equivalent to its occurrence in the modern pollen rain (70%). During the period of deposition of level 1, approximately 7700-7000BP, the AP frequency value decreased to roughly half of its value in the prior period. Subsequently, perhaps during the 7000-6500 BP interval, AP frequency again rose; this time reaching a mean value (23%) significantly higher than is the case in the modern pollen rain. By 6000 BP, however, AP frequency had again declined (19.5%).

Parallel variations in this sort of time-pollen sequence are known for a number of locations. In the Wasatch Mountains, at Snowbird Bog, near Silver Lake Brighton, Utah (Madsen and Currey 1979), the arboreal pollen record of the interval between radiocarbon dates of  $7920 \pm 210$  BP and  $5300 \pm 190$  is dominated by conifer pollen but incorporates up to 20% locally overrepresented alder pollen as well. Variations comparable

to those of the AP frequency value at Joe's Valley Alcove are thus expressed in the relative conifer: non-conifer pollen frequency value rather than the AP frequency. The curve for this statistic (op cit:265) shows three peaks for the 8000-6000 BP interval, but the earlier two are not segregated by a statistically significant decline and would be considered members of the same population by the standards applied at Joe's Valley.

At Sudden Shelter, single pollen spectra are available from each of the 5 superimposed strata dating between  $7090 \pm 85$  and  $6310 \pm 240$  B.P. (Lindsey, 1980a). (There is a date of  $7900 \pm 190$  provided for the same stratum which yielded the date of  $7090 \pm 85$ , but Jennings (1980:20) considers it probable that the sample producing the older date was mislabelled or improperly collected and dismisses it as valueless.) The AP frequencies of the pollen spectra dated  $7090 \pm 85$  and  $6670 \pm 180$  B.P. are roughly 50% higher than the average AP frequency value for the modern pollen rain at Sudden Shelter, while the AP frequency of the pollen spectrum dated  $6310 \pm 240$  B.P. and that which immediately precedes it is statistically equivalent to the average modern value. The direction of variation in the pollen record at Sudden Shelter thus parallels the situation at Joe's Valley for the two temporal horizons, but the degrees of variation involved are not identical.

At Cowboy Cave (Lindsay 1980b) a pollen sequence incorporating fifteen spectra covers the  $8275 \pm 80$  to  $6390 \pm 70$  BP period with some gaps; twelve of the records are bracketed between the dates of  $7215 \pm 75$  and  $6675 \pm 75$  BP, attributed to the same population. The eleven dating between  $8275 \pm 80$  to  $7215 \pm 75$  BP contain 50-60% AP (mean = 57.2%), while the eleven dating between  $7215 \pm 75$  and  $6675 \pm 75$  contain 20-40% AP (mean=27.3%). Though the available dating control leaves the issue problematical, the Cowboy Cave record is not inconsistent with that from Joe's Valley.

At Sand Dune Cave, north and east of Navajo Mountain, Utah, Hevly (1969) analyzed pollen samples of deposits associated with artifact assemblages assigned to the Desha complex. According to the assessment by Schroedl (1976), the artifacts associated with the pollen records are not older than 8300 BP nor younger than 6200 BP. In the sequentially organized pollen record of this interval there are two AP frequency peaks, preceded by and separated by lower values.

In the La Plata Mountains of Southwestern Colorado (Peterson 1981, Peterson and Mehringer 1976) variations in the arboreal pollen record are dated about 8300 and 6700 B.P. They are in the same directions as those in the Joe's Valley record which are thought to date between 8200 and 7700 B.P., and between 7000 and 6500 P.P.

On the southern margin of the Colorado Plateau, in the Arroyo Cuervo district of central New Mexico (Irwin-Williams 1973), pollen records have been analyzed which ostensibly cover the entire interval between 9500 and 1600 B.P. This pollen sequence remains unpublished because the exact correspondence between the sediments analyzed for pollen and the radiocarbon assays dating archaeological contexts have not been assessed in detail. Correlation of radiocarbon dates and horizons of dune stabilization has been established, however, which allows isolation of the portion of the pollen sequence relating to the 8500-6000 BP interval. At profile V of Anajo Shelter the lowest sampled sediments are estimated to date about 8000 BP. Relative AP frequency is high in those samples, declines in the succeeding samples, and increases again in the further superimposed samples. The yet more elevated samples, estimated to date 6000 BP, have lower AP values.

Further to the southeast, palynological data of the relevant time horizon has been studied on the Llano Estacado of Texas (Oldfield and Schoenwetter 1964, 1975), where it is identified as the Sand Canyon Post-pluvial and incorporates part of the preceeding San Jon Subpluvial. Radiocarbon dates indicate that an AP frequency increases paralleling that observed in the deposit beneath level I at Joe's Valley dates prior to 7000  $\text{BP}_{\text{A}}$  and values occur within the 7000-5000 or 7000-4000  $\text{BP}_{\text{A}}$  interval (See discussion of the Lubbock Lake II location, Schoenwetter 1975:116).

As might be expected, the degree of correspondence in time-pollen sequences with that observed at Joe's Valley decreases with distance. But the general relationship between temporal horizon and relative AP frequency value expressed at Joe's Valley is the same as that expressed elsewhere in southeastern Utah and even further south and east. These correspondences could be accidental, but the fact of correspondence justifies consideration of the time-pollen sequence as sufficiently credible for interpretation.

#### PALEOENVIRONMENTAL INTERPRETATION

Paleoenvironmental interpretation of the palynological sequences of Snowbird Bog (Madsen and Currey 1979) is based on the conifer frequency value and spruce:pine ratio. At Sand Dune Cave (Hevly 1969) interpretation is based on the juniper frequency value and a general comparison of pre-historic and modern surface sample pollen records. At Cowboy Cave (Lindsay 1980b) the Artemisia: pinyon + juniper pollen ratio was used. Paleoenvironmental interpretation of the Joe's Valley Alcove pollen



sequence could be made on similar grounds, except that the elevation of this site makes assessment of the pine:juniper ratio preferable to use of the spruce:pine or other ratios. It seems more judicious, however, to undertake interpretation of the Joe's Valley Alcove sequence in a distinctive fashion.

The Snowbird Bog palynological record constitutes one of the three forms of data leading to Madsen and Currey's paleoenvironmental reconstruction. To achieve that objective, they integrated the information on pollen variations occurring through time with the local record of sequential variations in the depositional history of Snowbird Bog and also with an assessment of late Quaternary glacial history of the Little Cottonwood Canyon area of the Wasatch Mountains. For the 8000-6000 BP interval, the result is reconstruction of temperature conditions based upon a prior reconstruction of local vegetation patterns:

About 8000 years BP the coniferous forest cover increased markedly, probably as a result of warmer-than-average temperatures which allowed conifers to invade sagebrush-dominated knolls, ridge sides, and alpine meadows... Between 6000 and 5000 years BP temperatures declined slightly but continued to be warmer than average. (Madsen and Currey 1979:266).

Though they did not incorporate the resulting inferences in their paleoenvironmental reconstruction, Madsen and Currey also argued (op. cit 264-266) that change through time in the spruce:pine pollen ratio at Snowbird Bog "probably provides an estimate of relative soil moisture..." This adds a dimension to the reconstruction that Madsen and Currey did not elaborate, since two maxima in the curve plotted for the spruce:pine

pollen ratio occur in the 8000-6000 year ~~BP~~ interval (op.cit:265). Taken in terms of the Holocene average spruce:pine ratio, these maxima are not significant indices of wet conditions of paleoclimate. From the perspective of the particular 2000 year interval, however, they indicate the occurrence of an earlier wet horizon at  $7920 \pm 210$  ~~BP~~ and a later one preceding 6000 BP separated by a period in which soil moisture conditions were about the same as those of  $1870 \pm 110$  ~~BP~~.

Hevly (1969) interpreted the pollen record of Sand Dune Cave in paleoclimatic terms as well, but concerned himself with relative moisture divergences from modern climatic conditions. Drawing upon comparisons of the fossil and modern pollen records which would identify vegetation distinctions and similarities, and on biostratigraphic correlations with the alluvial pollen chronology presented earlier by Mehringer (1967a), Hevly concluded that the pollen records of "

"...Strata II and IV could correlate with...mesic intervals, in which case Stratum III would date approximately between 8,500 and 10,000 BP" (Hevly 1969:395)

Hevly had previously argued (op. cit:393) that the similarity in pollen spectrum between Stratum III and modern surface samples of local juniper savanna indicated a prior pattern not significantly different from today's. Thus the "mesic" pattern inferred above relates to that standard. However, Schroedl (1976) has more recently assessed the antiquity of artifactual materials of the Desha Complex, and suggests that none pre-date 8300 B.P. or post-date 6200 BP. If Schroedl's evaluation is adopted, the "mesic" Sand Dune Cave must be no older than 8300 B.P., that of Stratum IV can



be no younger than 6200 B.P., and an interval of moisture conditions similar to those of today separates the two.

Jennings et al (1980:201) offer the cautious summary inference that the 8400-6300 B.P. interval was one of "favorable environmental conditions" at Sudden Shelter, though Jennings' (1978:92) earlier assessment of the paleoecological evidence was that a horizon of "considerable effective moisture" in the 8000-6000 B.P. interval was followed by a "markedly drier regime" until ca. 4000 B.P. Jennings (1978:92-3) also discusses the occurrence at Cowboy Cave of radiocarbon dated middens separated by culturally sterile sand deposits. He establishes the probability that the horizons of sand deposition reflect periods of aridity, allowing one to conclude that a dry interval occurs between 8275 $\pm$ 80 and 7215 $\pm$ 75 B.P. The duration or placement of the dry period within that interval, however, is not assessed, and the arboreal pollen frequency values of sediment samples of this antiquity indicates that one or more relatively wet episodes may also occur within that time span.

An encompassing paleoclimatic model is suggested by these segregate studies from the Wasatch range and adjacent portions of the Colorado Plateau in Utah. It would appear that independent variations in both temperature and precipitation occurred during the 8500-6000 B.P. interval, relative to the present. The entirety of the interval may be modelled as warmer than is the situation today, but relative variations index a cooler than average period within the 7500 BP to 6500 BP millenium. Generally speaking, the 8200-6000 BP interval may be modelled as about as arid as it is today, but relative variations index a wetter period essentially coincident with the somewhat cooler interval and an earlier quite wet

period dated at  $7920 \pm 210$  B.P. at Snowbird Bog and  $8275 \pm 80$  B.P. at Cowboy Cave. Acceptable radiocarbon dates for the strata at Cowboy Cave and Sudden Shelter that provide palynological evidence of the younger wet period are  $7215 \pm 75$ ,  $7090 \pm 85$ , and  $6670 \pm 180$  B.P.. A date of  $6675 \pm 75$  B.P. for a superimposed stratum, however, applies to pollen records deposited subsequent to the event. A minimum limiting radiocarbon date for a pause in the deglaciation process at Cottonwood Canyon ( $7515 \pm 180$  B.P.) may also reference <sup>the younger wet</sup> ~~this~~ interval. The younger wet period, then, which is also a period of somewhat cooler conditions, seems to date closer to 7000 than to 6500 B.P. The general picture seems to be one of warm wet conditions as early as 8300 BP; followed by a warm interval as arid as the situation today; succeeded by a somewhat cooler wet period dated as early as 7500 and as young as 6700 B.P., which was yet warmer than is the case today; succeeded by another warm <sup>r</sup> ~~dry~~ period to at least 6200 B.P.

On a broader geographic scale, this model is consistent with the record of Cordilleran glacial advance intervals proposed by Porter and Denton (1967). There are only two advance intervals indicated for the period of concern: Pinedale IV--dated  $8220 \pm 260$  B.P. in Montana--and Pinedale V, which is dated in the 7000-5000 B.P. range. Pinedale IV is widespread in the Cordillera and is correlated with the Cochrane - Coburn glacial advance in eastern Canada. Pinedale V is well evidenced only in the Sierra Nevada North of Lake Tahoe (Birkland 1964), though the Mount Ord glaciation in the White Mountains of Arizona (Merrill and Pewe 1972) and the Temple Lake glaciation of the Sangre de Cristo Mountains of New Mexico (Richmond 1963) may be correlates.

The model is also consistent with the paleoclimatic reconstruction offered by Mehringer (1977) for the great Basin Province, generated through his review and synthesis of geological, plant macrofossil, faunal and plant microfossil evidence:

Short term reversals of [a] trend [toward aridity] probably occurred shortly before...8000 B.P. By 7500 radiocarbon years ago, conditions were much like the present. Some researchers have suggested the persistence of extreme arid climates, hotter and drier than the present, for the next 3000 years. Perhaps this view is oversimplified as there is some evidence for a brief increase in effective moisture sometime between 6500-5500 radiocarbon years ago. (Mehringer 1977:148-149)

To the southeast, Oldfield and Schoenwetter (1975) have reconstructed climatic moisture fluctuations for the Llano Estacado which are also consistent with the model. They date the wet conditions of the San Jon Subpluvial to the horizon of the Cochrane glacial advance (op. cit:171) and suggest (op. cit:169) that the dry intervals of the succeeding Sand Canyon Post-pluvial were essentially similar to those which occur today while the wet interval was brief and lacking the intensity of a sub-pluvial event.

The model, then, seems not only to constitute a synthesis of paleoenvironmental reconstructions of the Wasatch range and adjacent territory, but also to identify paleoclimatic variations consistent with interpretations of paleoclimatic changes suggested elsewhere in the arid American West. Rather than attempt to confirm this general model through independent interpretation of the Joe's Valley Alcove pollen record, it seems judicious to consider the less complex issue of the degree to which the Joe's Valley Alcove record meets expectations generated by the general regional model.

There is no reason to presume that the Joe's Valley Alcove record would conform to any general model of regional paleoenvironmental variation. Indeed, there are three good reasons why we should expect that there would be no such relationship. First, the components of the Joe's Valley record do not have sufficient internal statistical strength to support argument that one or more pollen spectra may not diverge from the model as a result of chance. Second, and perhaps most important, the records from Sudden Shelter and Cowboy and Sand Dune Caves (which are significant to the generation of the model), the record from Lubbock II on the Llano Estacado (which is pertinent to documenting that model has broad regional applicability), and the record from Joe's Valley all derive from archaeological contexts. The prospect that associated cultural activity may have influenced the pollen frequency values of those locations in ways affecting paleoclimatic interpretation is decidedly real (note Lindsay 1980a:265). Third, though the model is consistent with paleoclimatic interpretations advanced for pollen sequences of the Great Basin and Llano Estacado, it is not consistent with those advanced for southern Arizona (Martin 1963), Tule Springs, Nevada (Mehring 1967b), Chaco Canyon (Hall 1977) or the Chihuahuan Desert (Bryant 1978; Meyer 1973). Though the model is consistent with the paleoclimatic inferences generated by analysis of Cordilleran glacial activities, it is inconsistent with the inferences generated by analysis of dated fluctuations in the level of great Salt Lake (Curry and Madsen 1974; Madsen and Berry 1975:398), or of vegetation community modifications developed on the basis of dated fossil pack rat middens (Van Devender and Spaulding 1979).

The general model suggests four expectations that would be fulfilled by the Joe's Valley record if it were applicable:

(1) Higher grass pollen frequency values should be evidenced for the 8300-6000 B.P. interval than is the case for modern surface samples (paralleling the consistently higher grass pollen frequency values at Sand Dune Cave and the higher conifer frequency values for the interval at Snowbird Bog) as indices of relatively higher paleotemperatures. However, a variation in grass frequency should be evidence for a cooler period between 7500 and 6500 B.P.

(2) Variations in the pine:juniper ratio (paralleling those of Sand Dune Cave and the pine:spruce ratio at Snowbird Bog) should occur as indices of relative change in paleoxericity. Maxima of the pine:juniper ratio should occur in the period dated  $7920 \pm 210$  and  $8275 \pm 80$  B.P. and again in a period bounded by dates of 7500 and 6500 B.P., separated by a period during which the pine:Juniper ratio should approximate that of the modern surface samples.

(3) The variation in pine:juniper ratio indexing moister conditions in the 7500-6500 B.P. period should coincide with the variation in grass pollen frequency values indexing cooler conditions, while a similar relationship should not be evidenced for the earlier moist period.

(4) The pine:juniper pollen ratio value for the earlier period of moister paleoclimate should be distinct from that indexing the later period of moister conditions in a fashion that indicates the earlier period was of a distinguishable intensity, if not duration.

The grass pollen frequency values of the surface samples range from 2 to 4%. Those of Bed I range from 7.5 to 76.0, conforming to the prediction of the general model regarding this index of higher temperature than occurs today. Two variations occur in the grass pollen



frequency during the deposition of Bed I, however, where the general model predicts one should occur. There is, as predicted by the model, a decline in the grass pollen frequency towards the modern standard in level 2 of Bed I, which is dated  $6760 \pm 180$  B.P.. But a statistically equivalent grass pollen frequency also is recorded for the deposit between levels 0 and 1, which must be bracketed between the dates of  $8210 \pm 220$  and  $7770 \pm 230$  B.P.

The variations in pine:juniper ratio predicted by the general model are observed in the Joe's Valley sequence. The younger maximum occurs in level 2 (range 43.0 to 142.0), and the older maximum (66.0) is recorded for the deposit between levels 0 and 1. The pine:juniper ratio for the sample collected at 183 cm at profile 186, level 1, is 1.3 and the ratio for the level 1 sample from profile 235 is 4.5. These approximate the situation for the modern surface samples, where the range is 1.0 to 2.0. The Joe's Valley record of variation in pine:juniper ratios does yield two values, however, which are not completely in accord with the model. The stratigraphically youngest sample from level 1 produced a pine: juniper ratio of 56.0, which is consistent with those of level 2 records but not similar to those which must represent an earlier period during the deposition of level 1. The stratigraphically oldest productive pollen sample of level 1, which is not from the base of the level, yields a pine:juniper ratio of 22.0. This is significantly higher than modern sample values but not a maximal value. Basically, the results for these samples are not those predicted from the general model, but they do not conflict with it either. The model predicts maximal pine: Juniper ratio values for certain periods of time, not depositional units.



The stratigraphically youngest sample of level 1 probably was deposited at the appropriate time. Alternatively, the model does not demand that the entirety of the time period between the two maxima will yield pine:juniper pollen ratio values approximately like those of modern samples; only that such values will occur during that period. In fact, this is the situation.

The third expectation predicted by the general model is that the relationship between pine:juniper and grass frequency values in the samples illustrating maxima in the moisture curve will not be similar. That is, that the pine:juniper ratio maximum of level 2 will accompany grass pollen frequency values of a different order than those which the maximum pine:juniper ratio value of the sample from the deposit between levels 1 and 0. This is not the case; the mean grass pollen frequency value of level 2 (11.25%) is statistically indistinguishable from that of the deposit between levels 1 and 0 (12.5%).

The expectation that the pine:juniper ratio values of the two maxima horizons should be distinct is also not confirmed by the Joe's Valley record. In part, this may be a function of the necessity of drawing comparisons between a single record of the older interval (66.0) against two disparate records (43.0 and 142.0) for the younger interval. As was noted earlier, though, the general character of the older record is such that it may be accurately described as a member of the same statistical population as the two younger records. Though sampling error could account for the lack of correspondence between results observed and results predicted by the general model, the weight of evidence is against that interpretation.

At first exposure, it appears that the general model is no more

applicable than not. One could therefore conclude that the Joe's Valley pollen record is either (a) influenced by factors not accounted for by the model, such as human behavior, or (b) a demonstration that the model is an inaccurate representation of the sequence, character, duration and intensity of paleoclimatic events. But there are problems with both these conclusions. If either conclusion were fully justified, it would be at least very curious that the Joe's Valley record would have the particular relationship that it appears to have <sup>to</sup> the general model. The model predicts very specific grass pollen frequency value relationships between Bed I and modern surface sample records, and very specific time-pollen variations in pine:juniper ratio values relative to the modern surface sample pine:juniper ratio values. These are in fact observed. It predicts finer scaled distinctions in relative relationships of the pollen records of certain temporal intervals which are not observed. However, the Joe's Valley record does not express data patterns of sorts which are inconsistent with the model either. If the Joe's Valley record were actually influenced by "other factors", or if the model was wholly inaccurate, one would expect even less conformity between the model and the Joe's Valley record than is observed.

My suspicion is that the lack of correspondence between predicted and observed results has been generated by two factors. One is that the model is, indeed, quite general in that it references conditions occurring over an enormous geographic territory. The other is that the specific expectations of the model are differentially evidenced at various locations within that territory.

For example, the inference that the two intervals of mesic conditions

are separated by an interval of xeric conditions similar to today's is based upon evidence from the Great Basin, the Llano Estacado, Sand Dune Cave and Cowboy Cave. The weight of evidence justifies this characterization of conditions in the general model and leads to the prediction of certain results at Joe's Valley. But the record from Snowbird Bog is not consistent with this aspect of the general model. At that site the spruce:pine ratio values reach minima during this interval which may be interpreted in the fashion predicted by the model, but which also are open to the interpretation that local conditions were more xeric than occur today. In another case, the inference that the two intervals of mesic conditions were not similar in duration or intensity is based upon evidence from the Great Basin and the Llano Estacado. The evidence from Sand Dune Cave, Cowboy Cave and Sudden Shelter does not address this inference, and that from Snowbird Bog is not congruent with it. Though the weight of evidence supports the model as proposed, the specific evidence provided at particular locations within the broad geographic area to which the model applies is not universally consistent with expectations generated by the model.

My inclination is to recognize that the failure of the Joe's Valley record to meet all the expectations of the general paleoclimatic model are effects of scale, while the congruence of the record and certain expectations suggests that the model is accurate as a general reconstruction. Neither palynological nor paleoclimatic theory are inconsistent with this interpretation. Palynological theory recognizes that the pollen records of specific locations are conditioned by ecological parameters existing within the source territory of plants contributing pollen to the observed

spectrum. Though these parameters are highly influenced by regional climatic conditions, they are also significantly affected by local factors influencing the vitality of source plant populations and the ways in which the local pollen rain is produced and dispersed. Similarly, paleoclimatic theory recognizes that the parameters of regional-scale climatic conditions are not identical to those expressed on a local scale. While global, regional and local paleoclimatic trends and episodic variations characterize the Holocene, geographic scale conditions the precise fashion by which they may be characterized.

#### SUMMARY

The Joe's Valley Alcove radiocarbon dates and pollen records are, in and of themselves, inadequate for confident interpretation of the antiquity and duration of paleoclimatic events. Interpretation of this sort requires the confidence generated by statistically adequate populations of radiocarbon dates and pollen samples controlled by stratigraphic position and episodic patterns of deposition. There were not enough radiocarbon dates generated per depositional unit, nor enough pollen samples collected per depositional unit, to satisfy these demands at Joe's Valley.

Development of a paleoclimatic reconstruction from the available record thus hinges on two arguments. The first argument proposes that the radiocarbon and palynological records, despite their statistical inadequacy, constitute evidence which may be interpreted in paleoclimatic terms because there is a high degree of correspondence between the data provided at Joe's Valley and that provided elsewhere in southeastern Utah.

Demonstration that the radiocarbon dating of the Joe's Valley depositional units and certain pollen statistics are congruent with those obtained at other locations does not prove that the Joe's Valley record is interpretable. It argues, however, that the Joe's Valley data is not less interpretable than other data sets from the region, and places the burden of proof that the records are not interpretable on those who remain skeptical.

The second argument addresses the question of the nature of the paleoclimatic conditions which occurred at Joe's Valley Alcove between 8200 and 6000 radiocarbon years ago, how those conditions varied through time, and the duration and intensity of the various paleoclimatic episodes. This argument progresses through the establishment of a general paleoclimatic model based upon the evidence and interpretations offered at a number of locations. The geographical scale of the general model encompasses the territory from the Great Basin of the Western United States through southeastern Utah to central New Mexico and the Llano Estacado region of western Texas. The model was utilized to identify a suite of four expectations regarding the interactive relationships of radiocarbon dates and pollen records at Joe's Valley Alcove. To the degree that the observed data correspond to these expectations, the records from Joe's Valley have been interpreted as expressions of the general model. To the degree that they diverge, I have chosen to interpret them as local paleoclimatic variations of the general model. This choice is justified on two grounds. First, both palynological and paleoclimatic theory accommodate such a position and indicate that it is normally a necessity for precise reconstruction. Second, similar localized deviations from the general model seem evidenced in the records of other localities in southeastern Utah.



The paleoclimatic reconstructions offered below for the time intervals represented by the depositional units of Joe's Valley Alcove may be viewed by those familiar with pollen analysis as speculative over-interpretations of an inadequate data set. Logically, though, acceptance of the above arguments justifies assessment of the data set as adequate to the demands of interpretation by the standards applied to comparable bodies of data. The reconstructions are most aptly characterized from the perspective of deductive logic as testable hypotheses generated from, and limited by, valid available data.

The thing that differentiates this reconstruction from others that have been offered (e.g. Lindsay 1980a, 1980b, Peterson and Mehringer 1976) is the geographic scale to which it applies. Traditionally, pollen studies proffer paleoclimatic reconstructions of a general nature in order to present conclusions applicable to fairly extensive geographical areas. In part, this is a function of the use of lacustrine and bog core data, which tends to reflect the pollen rain of entire basins of deposition and smooth independent records to points on curves. In part, it reflects the traditional concern of paleobotanists and Quaternary geology with biostratigraphic correlations over extensive areas, reconstruction of the characteristics of vegetation biomes, and considerations of synchronous paleoclimatic variations of continental scale. My concern is paleoclimatic reconstruction of value to archaeological study, scaled to the geographic level of the site and its presumed catchment area and relevant to the anthropological issue of the effects of environmental change on systems of human adaptation. I make no apologies to those who contend that the technique of pollen analysis may not be adequate to monitor



paleoclimatic variations of this limited scale. The fact that pollen analysis is not normally utilized as I use it here is relevant, but the reconstructions I offer are testable hypotheses, not speculations. Skeptics are invited to subject them to any independent tests they deem appropriate.

### CONCLUSIONS

The paleoclimatic reconstruction offered for the period of Archaic occupation of Joe's Valley Alcove is best expressed as a series of episodes distinguished by temperature and moisture variations. Relative to the climate of the area today, it seems always to have been warmer but never drier at this location between 8200 and 6000 B.P. Relative to the paleoclimatic conditions for the broad geographic area monitored by the general model, the Joe's Valley Alcove locality differed from other locations as regards both the duration and intensity of climatic variations. The sequence and directions of paleoclimatic changes expressed in the general model, however, seem to occur universally.

The earliest paleoclimatic episode monitored by the record at Joe's Valley Alcove is directly dated  $8210 \pm 220$  B.P. It seems not unlikely that the characteristic climatic conditions of the episode fall in the earlier portion of the one sigma range, however, since the subsequent episode is dated as occurring by  $7920 \pm 210$  B.P. in Wasatch Range and may date as early as the  $8275 \pm 80$  B.P. date indicated by the pollen record of Cowboy Cave. A date closer to 8300 BP would also be more consistent with Peterson's (1981) results. As monitored by the grass pollen frequency, this episode appears to represent a time which

was not significantly warmer than today but as warm or warmer than any other episode during the Archaic occupation. The pine:juniper ratio value apparently monitors physiologically effective soil moisture rather than climatic moisture. Taken in conjunction with the AP frequency statistic, which is thought to monitor tree density responding to the general precipitation pattern, <sup>(Schoenwetter 1970)</sup> however, a paleoclimatic reconstruction may be offered. During this episode soil moisture conditions approximated those of today but arboreal density reached a minimum level. The implication is an episode of extreme climatic aridity, apparently modified by a strongly seasonal precipitation pattern which provided soil moisture during the growing season. The earliest episode, then, seems to be one of intensely arid and quite warm paleoclimate in which the storm pattern may have been limited to convectional precipitation during the summer months. It is not clear when this episode began or how long it lasted, but peak conditions probably were encountered before 8200 B.P. and the episode most likely ended before 8000 B.P.

The succeeding paleoclimatic episode dates prior to 7770 $\pm$ 230 B.P. at Joe's Valley and is directly dated at 7920 $\pm$ 210 at Snowbird Bog and 8275 $\pm$ 80 at Cowboy Cave. Judging by the very limited deposits referable to this episode at Joe's Valley, it seems to have been of significantly shorter duration than the preceding and succeeding episodes. My guess is that it occurred for not more than the 200 years between 8100 and 7900 B.P., and may not have lasted as much as a century. This is the episode characterized as the earlier wet interval in the general model. Soil moisture levels seem to have been at least an order of magnitude above those monitored today by the pine:juniper ratio, though tree density

seems to have been in the range of that existing at the site today. The implication is that absolute precipitation values may not have been significantly higher than occur today but were seasonally distributed to a different physiological effect. As monitored by the grass pollen frequency value, paleotemperatures were significantly warmer than occur today but not as warm as those of the prior episode. The second episode, then, appears to have been one of ameliorated climate. It seems not unlikely that winter temperatures were less severe than they are today; that summer temperatures were not as high as had been the case a century or two earlier; and that rainfall was distributed through a longer growing season, though it was not unusually plentiful. The duration of this episode, however, was quite short.

The third episode of the sequence is represented by the pollen records of level 1 of Bed I at Joe's Valley, which provided a radiocarbon date of  $7670 \pm 210$  B.P. Level 1 is the thickest of the Archaic occupation horizon deposits, suggesting that the episode it represents had a long durational span. This inference is congruent with Jennings (1978) argument that a "markedly" dry interval represented at Sudden Shelter and Cowboy Cave is terminated by  $7215 \pm 75$  B.P. Granting the estimated terminal date for the prior climatic episode (7900 B.P.), the third episode seems to have had approximately five to six centuries duration. At Joe's Valley the pollen samples likely to represent the earliest portion of this episode yielded insufficient pollen for analysis. It is thus possible that the paleoclimate of the 7900-7200 B.P. interval was not as uniform as suggested by the available positive evidence, though neither the general model nor the data from other southeastern Utah sites supports such a hypothesis.

As monitored by the grass pollen frequency, paleotemperatures are indicated to be somewhat warmer than was the case in the preceding episode. Paleotemperatures may have approached the level indicated for the earliest episode in the first century after 7900 B.P. Soil moisture levels apparently varied through the episode from a situation similar to that occurring today to markedly (but not extremely) more, and tree density seems to have been about half that of today or the preceding episode. These indices imply that precipitation was not only lower than occurs today but probably biseasonal in character. Intervals of drought may have occurred within the episode.

The duration of the paleoclimatic episode monitored at Joe's Valley by the pollen records of Bed I level 2 is the most difficult to assess from present evidence. The associated date of  $6760 \pm 180$  B.P. represents a situation relatively late in the depositional history of this stratum. The high AP frequency associated with the  $7215 \pm 75$  B.P. date at Cowboy Cave and the  $7090 \pm 85$  date at Sudden Shelter correlates with that of Bed I level 2 at Joe's Valley, but Mehringer's (1977) estimate of the earliest date for the corresponding episode in the Great Basin is 6500 B.P.; the terminal date for the corresponding Pinedale V glaciation is estimated as late at 5000 B.P.; and the minimal antiquity for the Desha Complex at Sand Dune Cave and elsewhere is estimated by Schroedl (1976) as 6200 B.P. To complicate the problem, level 2 of Bed I at Joe's Valley can be divided into an earlier and a later substratum on the basis of the proportions of clay and the degree of charcoal staining. The radiocarbon sample was collected from the later substratum but the precise positions of the pollen samples relative to the microstratigraphy

were not recorded. Lindsay (1980a:261; , 265-266) has dismissed the date as a potentially spurious association with the pollen record, but my interpretation of the evidence is that a terminal date for this episode at Joe's Valley is probably very close to the radiocarbon date of  $6760 \pm 120$  B.P. Though level 2 does not have as great an average thickness as level 1, its sedimentary matrix is dominated by particles of smaller size. The inference that it represents as much or more absolute time is therefore not unreasonable. My guess is that the fourth paleoclimatic episode at Joe's Valley endured through most of the 7200-6500 B.P. interval.

The grass pollen frequency value of the level 2 samples from Joe's Valley indicates a paleotemperature regime markedly cooler than the preceding episode yet significantly warmer than occurs today. The pine: juniper ratio values, which are of the same order as those of the second paleoclimatic episode, indicate quite high soil moisture levels. The AP frequency statistic, which is significantly higher than that of the surface samples and considerably more influenced by pine pollen, indicates the highest tree density values experienced during the period of Bed I deposition. The record suggests an episode of long duration prior to which a significant climatic change had occurred. Both winter and summer temperatures were lower than in the preceding episode. Precipitation was markedly more abundant than is the case today, and was probably distributed through all seasons of the year.

The final paleoclimatic episode associated with the Bed I occupations of Joe's Valley Alcove, in my estimation, is reflected in the pollen record from level 3 at Profile 186. The radiocarbon date from this level



(6200±190 B.P.) was collected 15 cm above the base of the stratum and is thought to mark the approximate end of the Bed I occupation. The Snowbird Bog record documents the inception of a subsequent, non-corresponding, wet paleoclimatic episode prior to 5600±180 B.P. It would appear that the final paleoclimatic episode represented in Bed I at Joe's Valley was not of the duration of the two prior episodes. Depending upon where one guesses the inception horizon of the subsequent episode at Snowbird Bog to be, one may estimate the duration of the final episode at Joe's Valley between a minimum of 100 and a maximum of 700 years. My suspicion is that an inception date of 6500 B.P. and a termination date of 6200 B.P. are the most reasonable, indicating a duration of 300 years.

The grass pollen frequency value of this fifth episode is of the same order as the second episode, and the pine:juniper ratio and the AP frequency value parallel those of the third episode. The record implies reestablishment of the sort of paleoclimatic pattern which had existed in the 7900-7200 B.P. period. Though cooler than is the situation today, the episode was one of warm conditions and lower rainfall than occurs at present. Storms were probably limited to the winter and summer seasons, and drought years may have been common.

#### ARCHAEOLOGICAL IMPLICATIONS

The regional model and site-specific reconstructions of Archaic Horizon paleoclimatic changes which have been presented above bear upon fairly broad issues of Southwestern prehistory. This does not occur because the reconstructions which have been offered are demonstrably valid. Indeed, I am well aware that they are presented as (as should be

considered none other than} evidenced hypotheses open to independent confirmation or rejection on the grounds of additional or other data. The reconstructions bear upon broad issues because whether they are accurate or not they raise questions about the ways archaeologists have thought appropriate for investigating the relationship between environmental variations and systems of cultural adaptation.

One of the most stoutly defended theories of North American archaeology (viz. Jennings 1979:154-182) maintains that all the Archaic Horizon populations of the Southwest were adapted to local environmental conditions through the same two cultural mechanisms: a flexible hunting-gathering subsistence strategy and a generalized technology. If the reconstructions presented are accurate only insofar as they document degrees and levels of paleoclimatic variation in space and time, they offer direct and real challenges not only to that theory but to the assumptions and methods which are applied to justify it.

Let us (I hope momentarily) presume that the general paleoclimatic model proposed above is accurate in only one respect. Let us grant that it is erroneous in the reconstruction of both the timing and directions of paleoclimatic variations, and accurate only in its recognition that the evidence consistent with some kind of regional paleoclimatic reconstruction of the Joe's Valley record is limited to a part, not all, of the American Southwest.

No 18 The archaeologically significant aspect of the general model is not that it identifies horizons of time when arboreal pollen frequencies rise and fall or even periods when climatic conditions changed. It is that it indicates that some large geographic areas of the American Southwest underwent different sequences of paleoclimatic modification than others.

The general model presented above does not cover the entirety of geographic space addressed by the "Desert Culture" theory of Archaic Horizon Southwestern prehistory. A different model is clearly required to accommodate the strand level evidence of the Great Salt Lake basin, and at least two other general models are necessary to accommodate the dissimilar paleontological records of the Chihuahuan, Sonoran and Mohave Desert regions. The general model thus presents the Desert Culture theory with the challenge of explaining how a single technology and a single subsistence strategy could cope with distinctive types and sequences of environmental changes without divergence into regionally specialized adaptive trajectories.

This challenge has been made previously. Irwin-Williams and Haynes (1970), presented arguments based on the archaeological evidence of assemblage formations and population movements which suggest that regionally specialized adaptive strategies did, in fact, exist in the Southwest throughout the Archaic. The character of the archaeological record, however, requires these arguments to recognize that the <sup>Desert Culture</sup> theory appears to be valid at the level of describing the general character of human adaptation in the Southwest's arid and semi-arid lands during most of the late glacial and Holocene periods (Irwin Williams 1967, 1968, 1979; Irwin Williams and Haynes 1970). The nature of the archaeological evidence also suggests that in the particular case of the Great Basin region, the Desert Culture theory effectively assesses the subsistence-economic adaptive relationships of a single human population.

The specifics of a debate grounded upon arguments from archaeological evidence cannot be addressed by any amount of paleoclimatic reconstruction. Recognition that climatic conditions were variable over space and time in

the Archaic Southwest does not demonstrate that different adaptive strategies must have been employed at different times and different places. But the fact that interpretations of two distinctive forms of evidence independently challenge the same proposition of the Desert Culture theory may indicate the challenge is not easily dismissed.

Interestingly, the evidence of the general model and the archaeological evidence lead to non-congruent assessments of the adaptive systems of Great Basin Archaic populations. The general model would indicate that variation over time in subsistence and economic relationships would be expected, while the lack of significant change in artifact assemblages and the evidence of dietary patterns indicates that no such variation occurred. However, it can be recognized that the conclusion drawn from the archaeological evidence rests upon acceptance of an assumption: that the principle anthropological significance of the archaeological record involved is the opportunity it provides to identify the subsistence activities and survival strategies of the population that produced it.

This assumption is widely maintained. It is an equally integral feature of standard definitions of Archaic Southwestern culture presented by both parties in the debate (Jennings 1956 et seq, Irwin-Williams 1968 et seq):

The term Southwestern Archaic, here, connotes cultures characterized by a semi-nomadic mixed hunting-gathering economy. Typically, such an economy was neither solely dependent on hunting large, now extinct, fauna, nor at the opposite extreme was it in possession of a sufficiently stable resource base to promote true sedentism. (Irwin-Williams 1968:19)

But one may question the proposition that the available archaeological record is more aptly interpreted in terms of what people ate and how they obtained it than in any other terms. Those uniformities of the archaeological record which are presently interpreted as indices of cultural adaptation to the food resource potential of an area may, for example, document the degree of connectivity and information exchange between segregate, small, semi-nomadic populations. Or they may reflect uniformities in social, ceremonial or political organizations extending over broad ranges of space and time. Similarly, the technological, assemblage, and demographic distinctions of the archaeological record which are presently interpreted as evidence of economic differentiation at the "historico-genetic" level of cultural analysis may be reflections of intra-population processes of sociological character, such as ethnic identification.

My point is not that the general paleoclimatic model implies the need to restructure and re-orient our conception of the anthropology represented by the archaeological record of the Archaic Horizon in Southwest. Clearly, it cannot. What it implies is that areally extensive Archaic populations within the Southwest--the sorts of populations whose archaeological remains have been taken to represent independent cultures--seem to have experienced quite different sequences and types of environmental context variations throughout millennia of their culture histories. Yet in many ways they remained very similar to one another as such things are expressed in archaeological data. It seems not unreasonable, then, to suggest that the archaeological uniformities and distinctions observed may not be most aptly explained by



current theories of the anthropology of those populations. What appears to me to be the restrictive characteristic of existing theoretical positions is a presumption that cultural adaptation to environmental context is a matter of strategies of subsistence and biological survival. It is the challenge of this assumption that precipitates my interest. The opportunity this pollen study provided to establish a general paleoclimatic model merely prepared new ground for my previously stated skepticism of this notion. Equation of the terms "subsistence strategy" and "economy", and equation of either with the term "adaptation", constitutes a bone of contention I've picked at for more than a decade (Schoenwetter and <sup>Di</sup>Attert 1968:60-61).

The specific paleoclimatic reconstruction provided for Joe's Valley Alcove also challenges the Desert Culture theory. One of the most interesting implications of that reconstruction is that the duration and intensity of the paleoclimatic episodes at Joe's Valley differs significantly from the situations indicated for other localities in the region encompassed by the general paleoclimatic model. On the Llano Estacado, for example, the paleoclimatic episode corresponding to the second episode in the Joe's Valley sequence is called the San Jon Subpluvial. At Joe's Valley this episode lasted two hundred years or less and is most aptly characterized as an amelioration of earlier intensely arid and quite warm conditions. On the Llano this episode lasted at least a thousand years, it precipitated the establishment of quite different vegetation patterns than had ever occurred previously, and it is most aptly characterized as a horizon of substantive climatic variation. Similarly, the fourth paleoclimatic episode at Joe's Valley seems to have lasted

about 700 years and seems to have been induced by significant climatic change. At Cowboy Cave it seems to have been a much shorter episode, and the corresponding episode in the Great Basin is so slightly demarcated in available records that it is only noted by Mehringer (1977:149) as represented by "some evidence" and is characterized as "brief" and perhaps of a different antiquity.

These contrasts imply that within the region to which a general paleoclimatic model applies, different localities and different districts witnessed distinctive patterns of paleoclimatic change through the millennia of Archaic occupation. When one conceives of such localities and districts as the catchment areas and territories of human populations, it becomes very difficult to conceptualize (a) the continuing adaptive significance to any population of a broadly flexible subsistence strategy, or (b) the cultural mechanisms that would operate to reject exploitation of the specific highly abundant food resources available in particular locations. Present theory regarding the anthropological nature of Archaic culture systems in the Southwest is therefore as much challenged by the particulars of paleoclimatic reconstruction as it is challenged by the existence of a general model. The paleoclimatic reconstructions presented imply that <sup>at</sup> the level of catchment areas and territories available <sub>A</sub> for subsistence strategy implementation, the sort of environmental uniformity demanded by the theory simply did not exist. Again, I suggest that the problem centers on the assumption that subsistence and survival strategies express the principle and significant adaptive relationships between a human population and the biophysical environment.

I cannot and do not claim that the arguments and conclusions presented

here demonstrate that this widely held assumption is false. I can only express recognition that this effort challenges existing theories of Southwestern Archaic anthropology on both general and specific levels and implies that something is strangely amiss. Hopefully, that recognition has directed my attention appropriately and has resulted in a correct identification of the root of the problem. If so, what is suggested is that archaeologists should recognize that human adaptation to the environment is a system that is not assessable simply as a set of strategies. It seems likely that there were many such systems in the Southwest at any given time during the Archaic. It <sup>also</sup> seems likely ~~to me~~ that the ways we presently identify the cultural functions of artifact and assemblage types and classes will not continue to prove productive of anthropological insight.

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